Luleå University of Technology Research and education related to extraction and recycling of minerals and metals

Caisa Samuelsson, professor in

Process Metallurgy

Division of Minerals and Metallurgical Engineering, MiMeR

Organisation

- Luleå University of Technology
  - Six Departments
- Department of Civil, Environmental and Natural Resources Engineering
  - Eight Divisions covering a.o Geoscience and Environmental Engineering, Chemical Engineering and Mining and Geotechnical Engineering
- Division of Minerals and Metallurgical Engineering, MiMeR
  - ~30 employees

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Division of Minerals and Metallurgical Engineering

Two research subjects:

Process Metallurgy **Mineral Processing**

<u>five full professors:</u>

Process Metallurgy **Mineral Processing**

Hydrometallurgy

Sustainable Production of Iron Ore (vacant) **GeoMetallurgy**

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Fields of competences - Mineral processing

Areas of application: Ore beneficiation, Industrial minerals processing
Coal preparation, Industrial residue recycling and waste utilization

Material characterization

of particulate solid materials

Particle analysis (size, shape, spec. surface area, particle density, zeta-potential, wetability, bulk flow properties)

Mineral analysis (composition, texture and mineral liberation) and process mineralogy

Special knowledge of a variety of mineral raw materials (different metal ores, industrial minerals and coal) as well as solid waste materials

Process knowledge

Comminution,
Agglomeration
Separation processes (solid-fluid separation, classification and sorting (esp. flotation, magnetic separation, gravity separation)

Mineral surface chemistry and bio-processing

Process development,
Design and scaling of equipment,

Simple and rigorous process modeling

Process systems engineering

Process analysis (test planning, plant sampling, mass balancing, data reconciliation, flowsheet simulation, DEM simulation)

Synthesis of flowsheets and process design

Geometallurgical modelling and production forecasting

Single and multiple objective optimization and life cycle assessment

Fields of competence - Process metallurgy

Areas of application: Sintering and oxidation metallurgy, Reduction metallurgy, Metals recycling, Residue treatment and recycling, Base metals metallurgy, Hydrometallurgy

High temperature chemistry Reactions during oxidation and reduction Reductants (coke, bio- etc) Impurity distributions	**Slag chemistry** Impurity capacities Solidification Leaching Stabilisation	**Hydro-metallurgy** Chemical- and bioleaching of complex sulfide concentrates and secondary materials	**Modelling** Thermody-namic modelling (FACTSAGE) Process Modelling (Simu-SAGE)	**Mineralogical characterisation** SEM-EDS/WDS Optical microscopy LA-ICP XRD TG-DTA/DSc-MS Image analysis Isothermal calorimetry (TAMair)

Resources - Process metallurgy

- Totally 3 professors
  - Process metallurgy,
  - Hydrometallurgy
- 1 adjunct professor, 5 other permanent staff, 7 PhD students and 3 active industry PhD students
- Well equipped laboratories for high temperature experiments, leaching, particle characterisation, mineralogical characterisation, bench and laboratory scale equipment for unit operations in beneficiation. Modeling especially thermodynamic modeling
- Good collaboration with Swedish mining, metallurgical and recycling industry
- Several projects in collaboration with Swerea MEFOS
- Education of engineers in Mineral Processing and Metallurgy within study programme Sustainable Process Engineering

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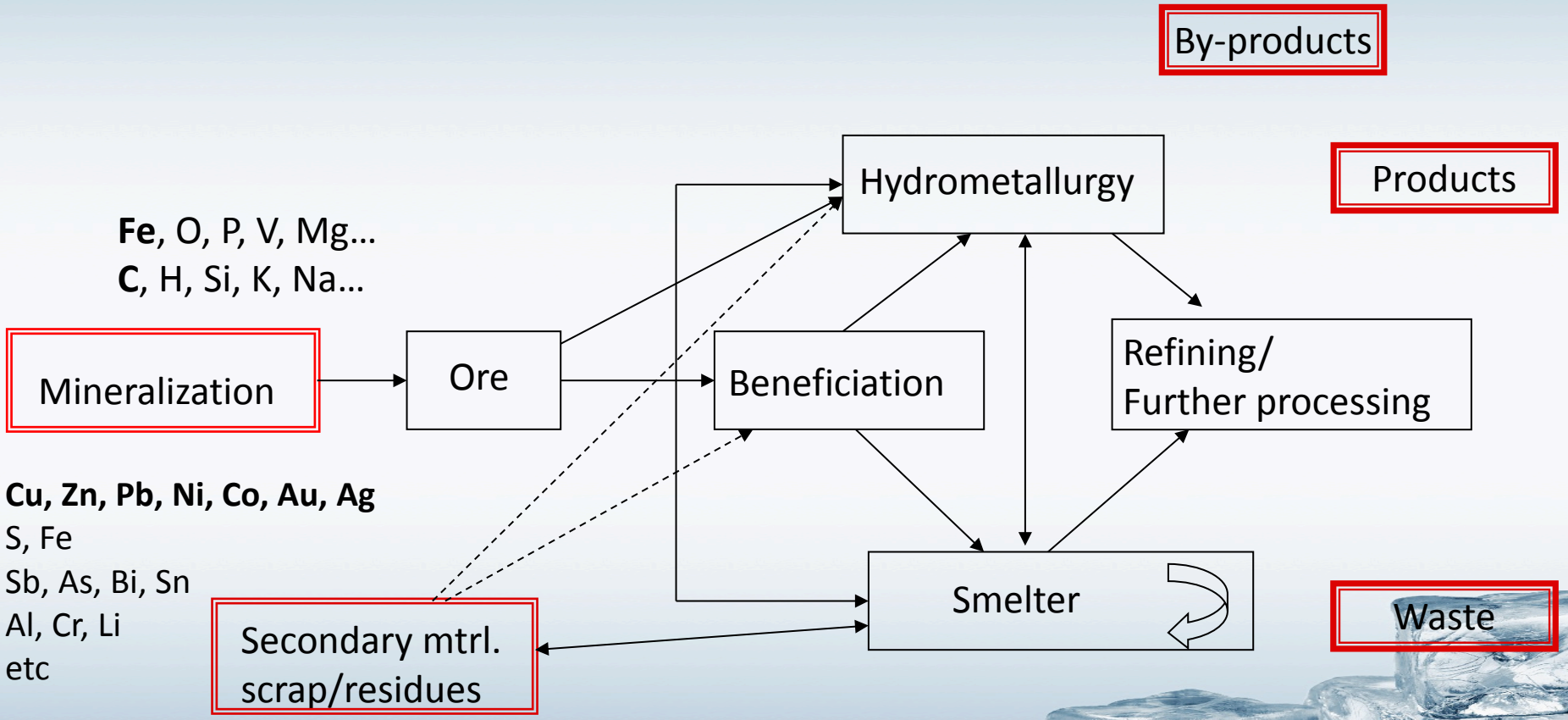
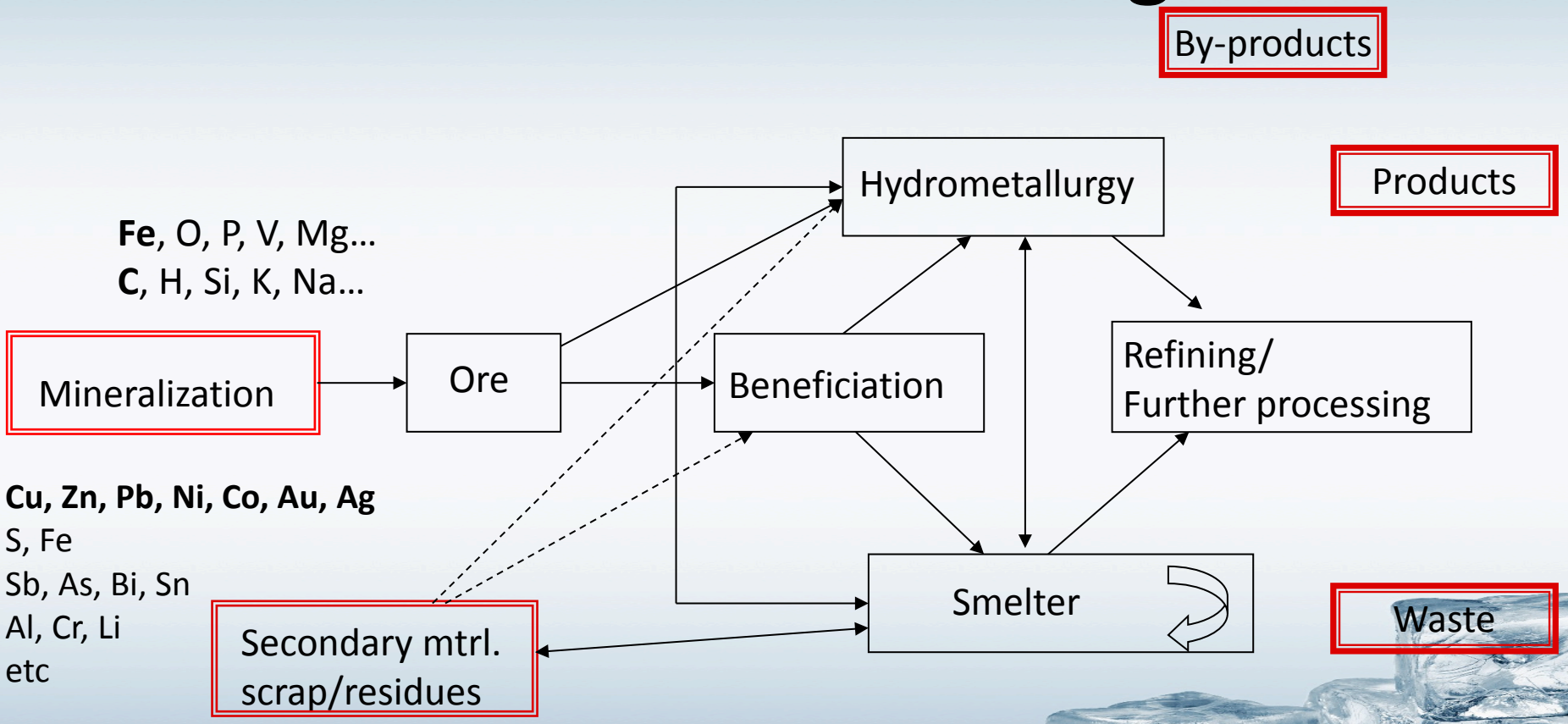
Wise Process Routes

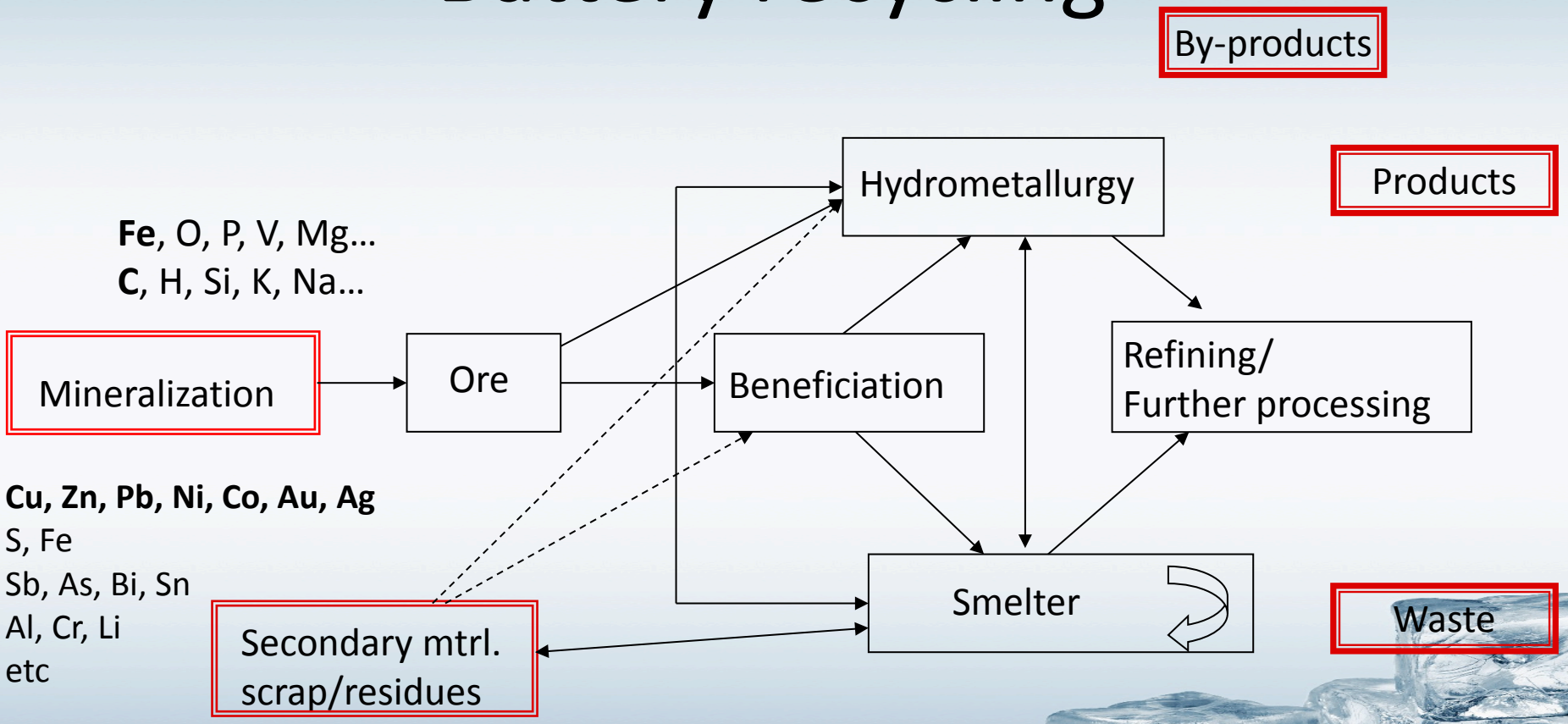


Wise Process Routes
Alternative reduction agents



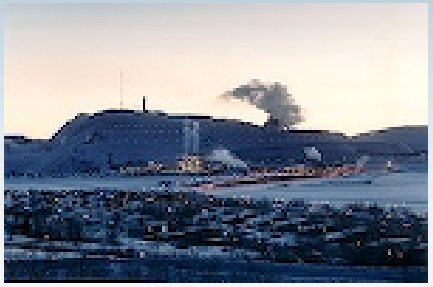
Use of waste plastic, biomass etc, for reduction in metallurgical processes

Wise Process Routes
Battery recycling



Cu-smelter: probable main distribution
Li, Al ⟶ Slag, Co, Ni, Cu ⟶ matte/metal electrolysis. Possibilities to change distribution?
Combine hydro- and pyrometallurgy

Sustainable Process Engineering



Raw material → Process Engineering → Products

Recycled products/material

Environment

Economy

Specialisations on Master level

Sustainable mineral and metal extraction

Renewable products and fuels

Concluding remarks

- Competence in the whole mining-metallurgy chain within CAMM (Centre for advanced mining and metallurgy, one of the governmental funded SFO) at LTU
- Close cooperation between Industry, Institute and University
- Good international collaboration
- PhD studies- 5 year studies (employment at LTU)
  - Often research projects together with industry
- Integrating undergraduate, postgraduate and research
- Undergraduate studies

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